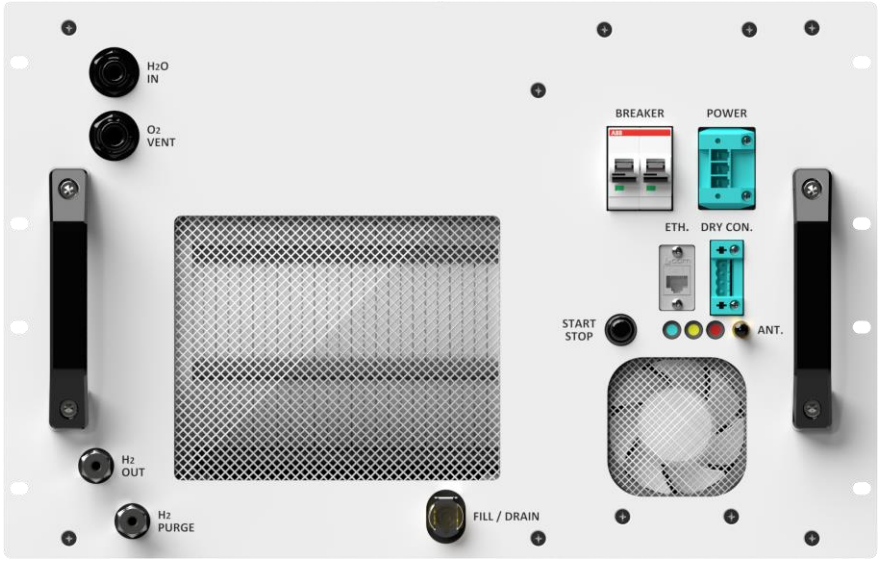
Enapter

The AEM Electrolyser

TECHNICAL PRESENTATION



OUR COMPANY

Enapter at a glance

Enapter is a rapidly-growing energy technology company. We leverage Anion Exchange Membrane (AEM) tech and its unique advantages. It allows for the mass production of electrolysers as products, not projects.

Based on our projections, we expect hydrogen from AEM electrolysers to be cheaper than from any other source.

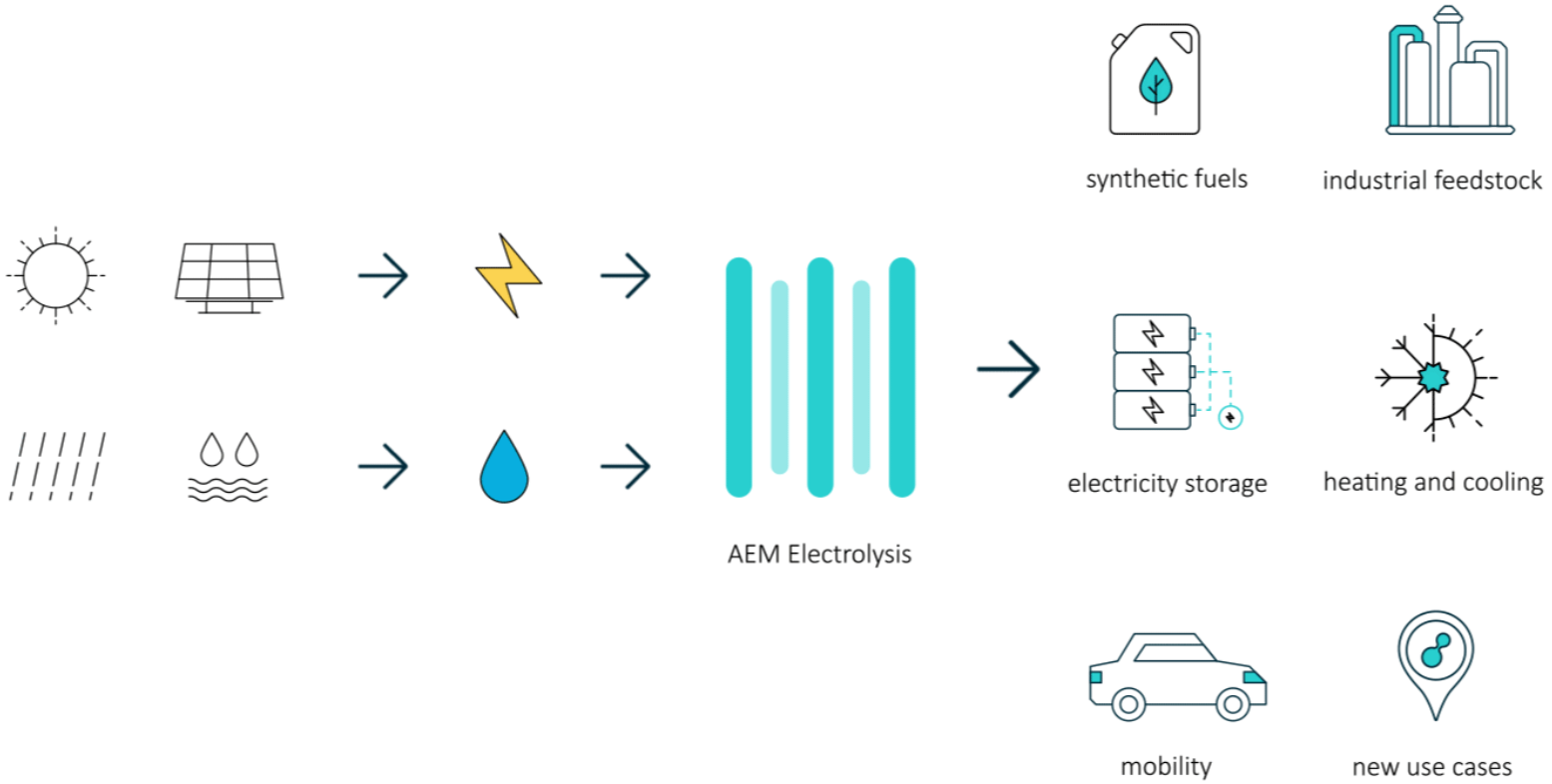
Serial entrepreneur Sebastian-Justus Schmidt started Enapter in November 2017. We have since made big strides in developing product and growing to 205 employees by December 2021.

Enapter accessed the capital markets in August 2020 via a reverse merger. We're on the regulated market of the Frankfurt and Hamburg Exchanges (ISIN DE000A255G02).

Next up: scaling our production and mass producing our AEM electrolysers.

MULTITALENT HYDROGEN

The decarbonisation molecule



Green hydrogen is a multi-talent when it comes to replacing fossil fuels.

With solar or wind power and water we can provide easily storable, transportable and versatile energy for all applications.

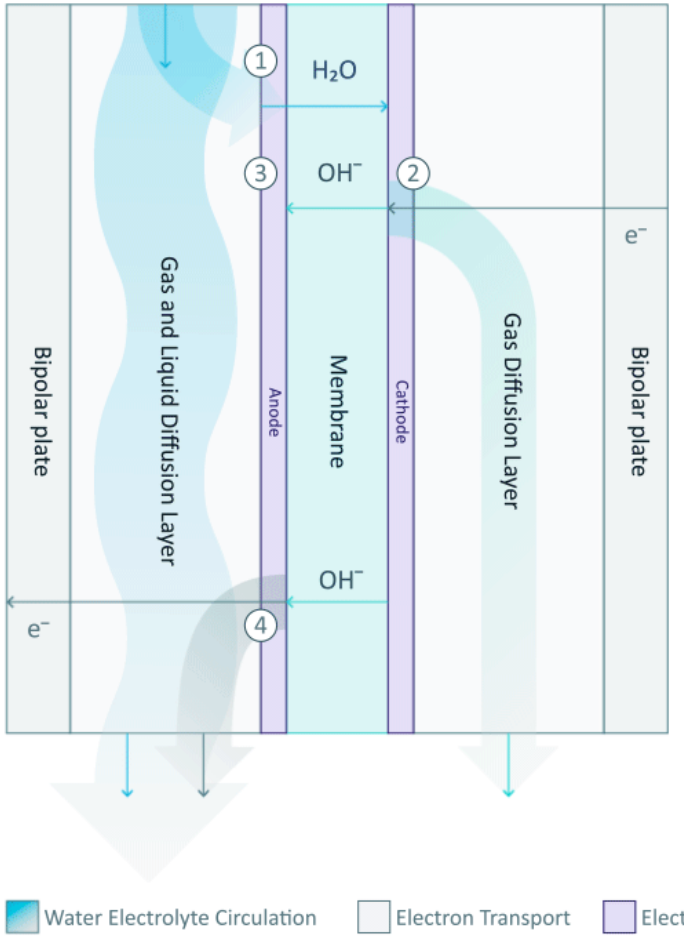
This molecule gives us the tool to decarbonise all sectors – including those that have proven difficult to electrify.

PATENTED AEM TECHNOLOGY

Our secret sauce

The strengths of our AEM Electrolysers:

- Combining the best of trad. Alkaline and PEM technology
- Low-cost materials and setup
- Top efficiency
- Easy to install and handle
- Low OPEX
- Strong patents granted, more pending



1. Water travels from the anode half-cell through the membrane.
2. Hydrogen is produced at the dry cathode and released via the gas diffusion layer.
3. OH- moves back to the anode via the membrane.
4. Oxygen is produced from OH- at the anode and released via the gas and liquid diffusion layer.

THE MODULAR AEM ELECTROLYSER

EL 2.1 Electrolyser

Hydrogen Production
500 NL/hr or 0.5 Nm³/hr

Efficiency
4.8 kWh for 1 Nm³ of H2

Hydrogen Purity
~99.9%

Power Consumption
2.4 kW

Input Water Purity
<20 µS/cm

Output Pressure
35 bar

EL 2.1
Serial Production started in March 2020

DRYER

The DRY 2.1

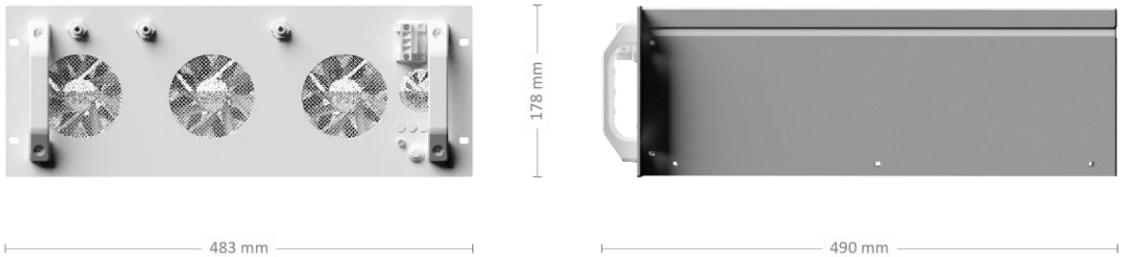
Hydrogen flow rate at 35 bar
up to 2.5 m3/hr

Hydrogen output purity
>99.999%

Dewpoint (after drying)
-70 °C

Power consumption
200 W (operative)
10 W (standby)

Power supply
AC 200-240 Vac,
50/60 Hz



DRY 2.1

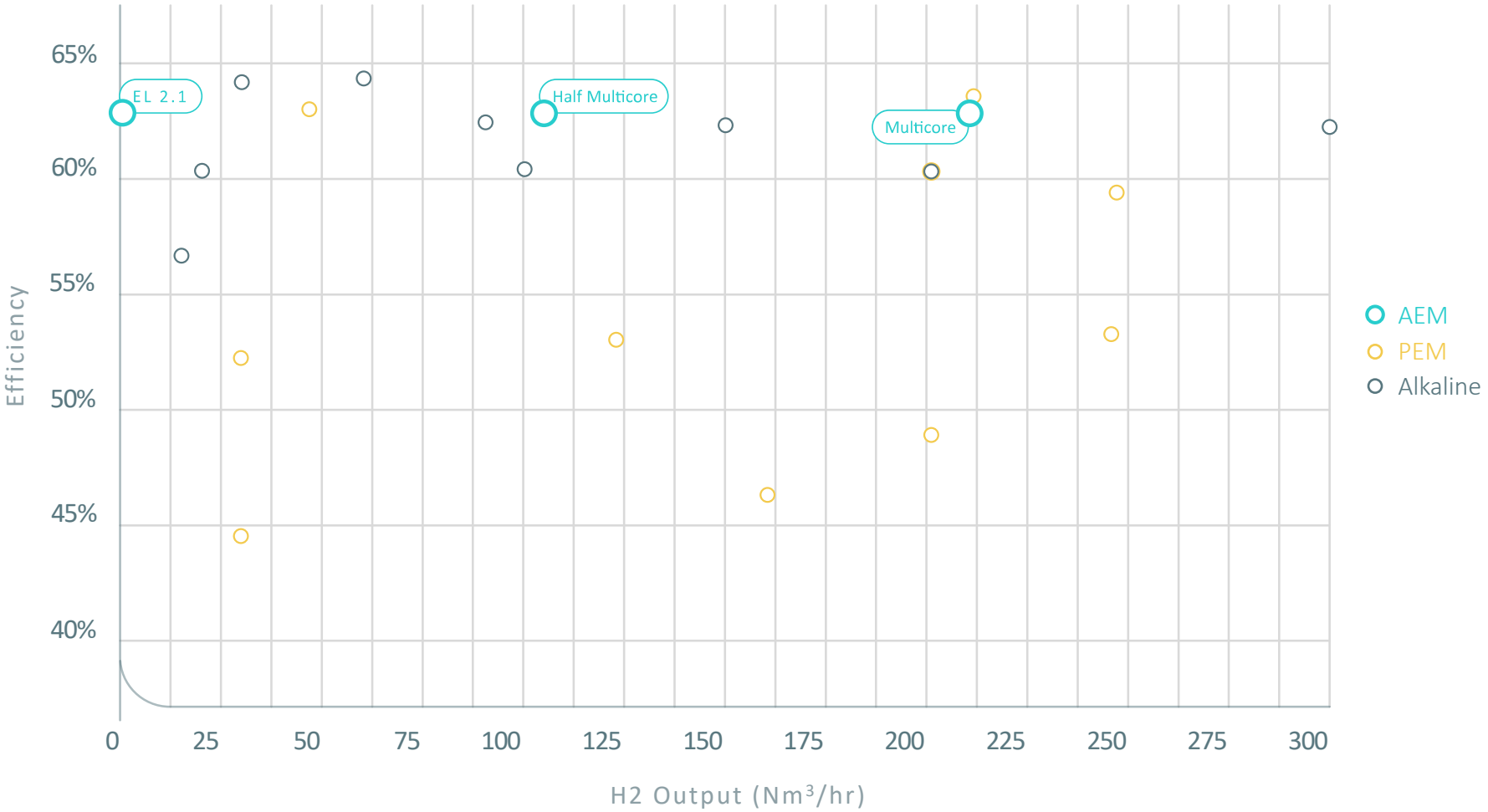
COMBINING THE BEST OF TWO WORLDS

AEM technology advantages

	PEM	Alkaline	Enapter AEM
High H_2 Purity	✓	✗	✓
Output Pressure	30 bar	atm	35 bar
Consumption (kWh/Nm^3 H_2)	5.1	4.9	4.8
No caustic electrolyte	✓	✗	✓
No costly components	✗	✓	✓
Fast ramp time	✓	✗	✓
Compactness	✓	✗	✓

SYSTEM EFFICIENCY

How does AEM efficiency compare?



Efficiency values from 10 electrolyser manufacturers.

Values are calculated from publicly available information (datasheets & presentations) as of July 1st, 2021.

Efficiency values are based on LHV, nominal output, nominal power consumption at the system level.

(10% BOP power consumption are added for datasheets which only indicate values on the stack level).

[r]Evolution of the AEM Electrolyser

TODAY

EL 500
02.2018

Height: 10 Units

- Separate stack and control modules
- Significant onsite installation tasks
- All 4 sides of the module need to be accessible for air flow, electrical, gas connections

€ 15,900

EL 2.0
01.2019

Height: 8 Units

- 9 cm smaller than predecessor
- Single module simplifies onsite installation
- Front-to-back airflow
- Integration into Enapter EMS allows mobile setup and remote monitoring
- New stack 40% smaller

€ 11,000

EL 2.1
02.2020

Height: 7 Units

- 4.5 cm smaller than predecessor
- 5% less energy needed and low standby power
- Revised interface hot-swapping
- OTA capability for new features

€ 9,000

EL Model 4
2022

Height: 6 Units

- 4.5 cm smaller
- Longer lifetime
- 40% less weight
- Final assembly time 1 hour
- Water cooling option
- DC-DC option

EL Model T/X
2022/2023

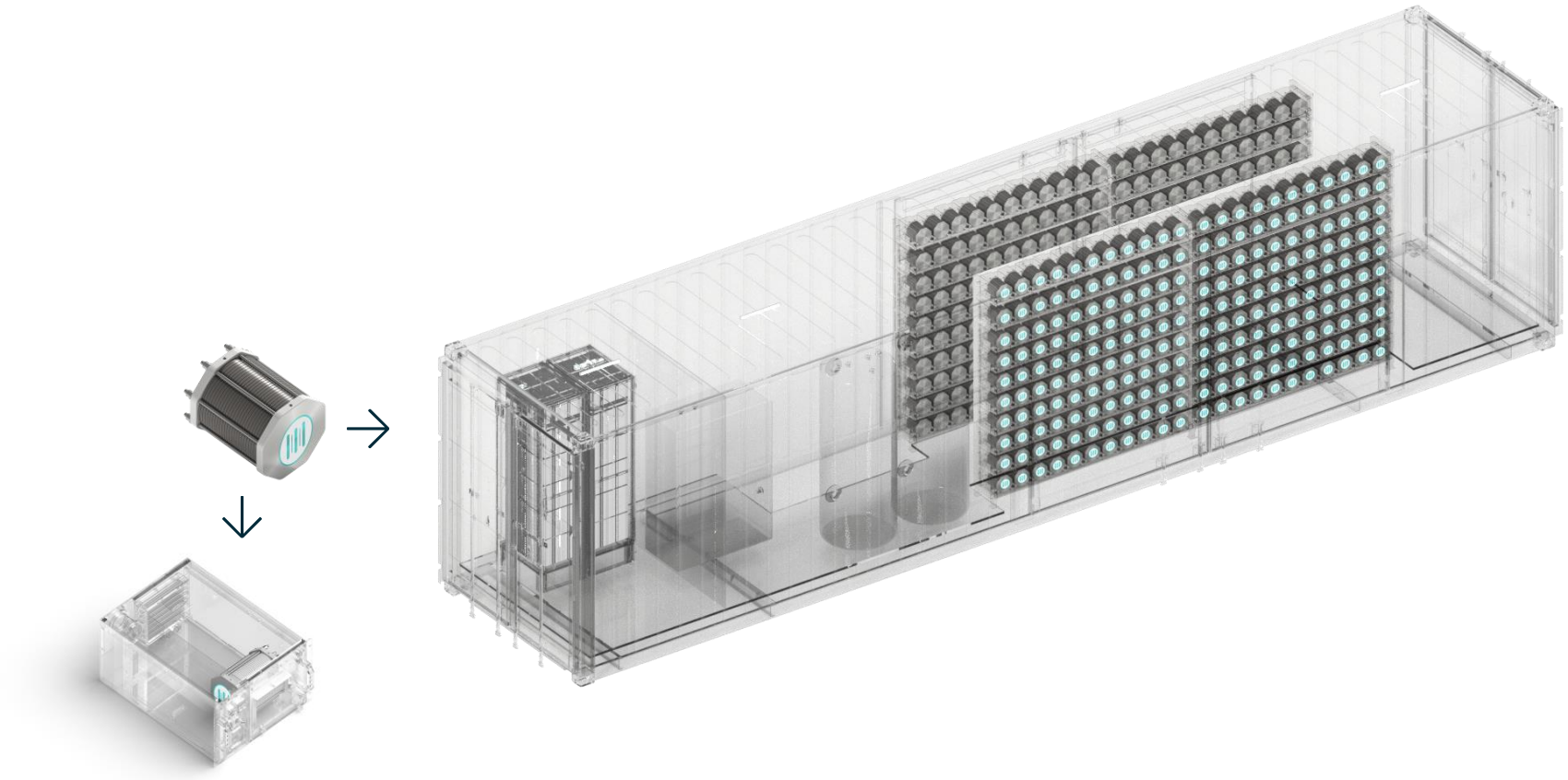
Height: ??

- Longer lifetime
- Reduced footprint
- Reduced weight
- Higher hydrogen output

€ 2,500 → € 1,000 by 2026

PLATFORM STRATEGY

Modular AEM cores: compact to scale



The "AEM stack" module – a single AEM electrolyser core – is the foundation of Enapter's product platform.

Our mass-produced AEM stack forms the heart of our compact, modular AEM electrolyser, the EL 2.1. But it also delivers megawatt-scale green hydrogen when 420 of them are deployed in our ready-made AEM Multicore system.

This product platform approach allows us to increase our speed of product development, reduce development costs, and rapidly increase product variety.

MEGAWATT CLASS

AEM Multicore™

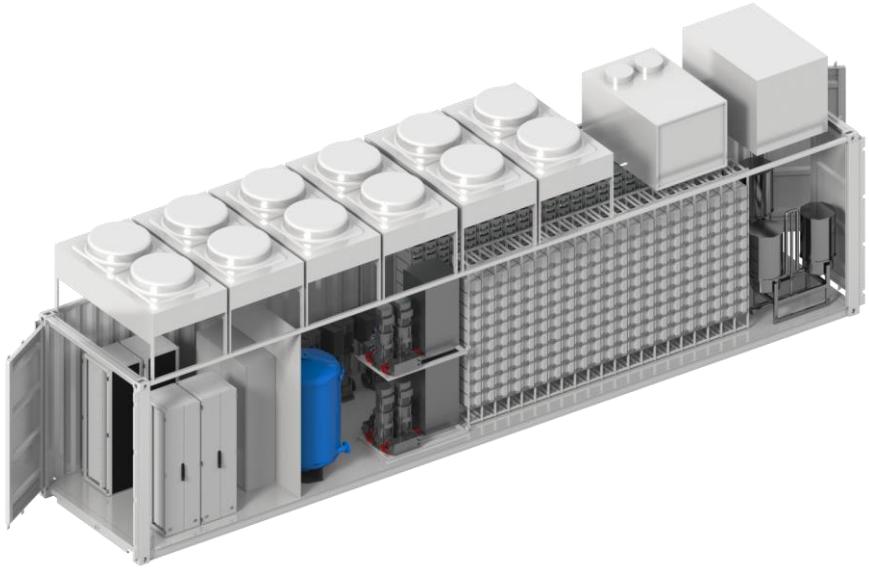
Hydrogen Production
210 Nm^3/hr

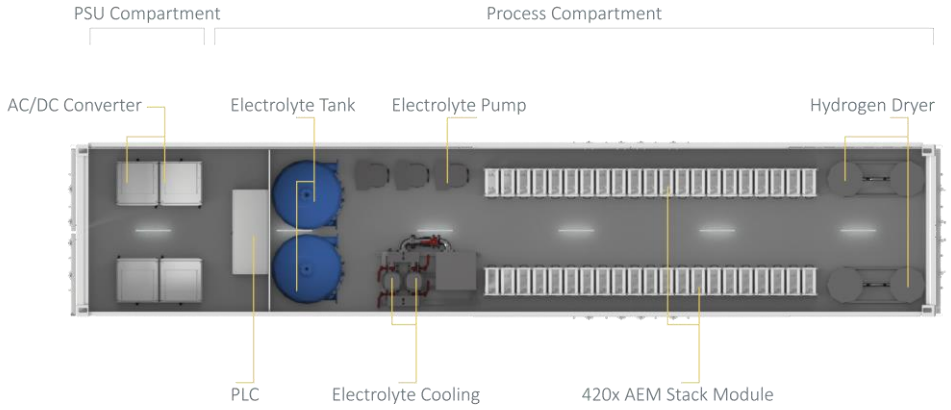
Hydrogen Purity
~99.8%, 99.999% with optional dryer

Power Consumption
1,008 kW

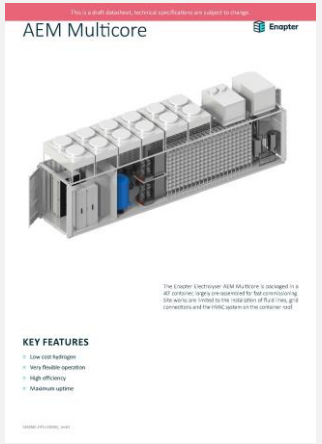
Efficiency
4.8 kWh/Nm^3

Output Pressure
Up to 35 bar





AEM Multicore
Serial Production planned in 2023



- 40-foot modular container
- Self-contained with:
  - Water preparation
  - Power distribution
  - H2 safety
- Fully automatic with Enapter's EMS, Modbus

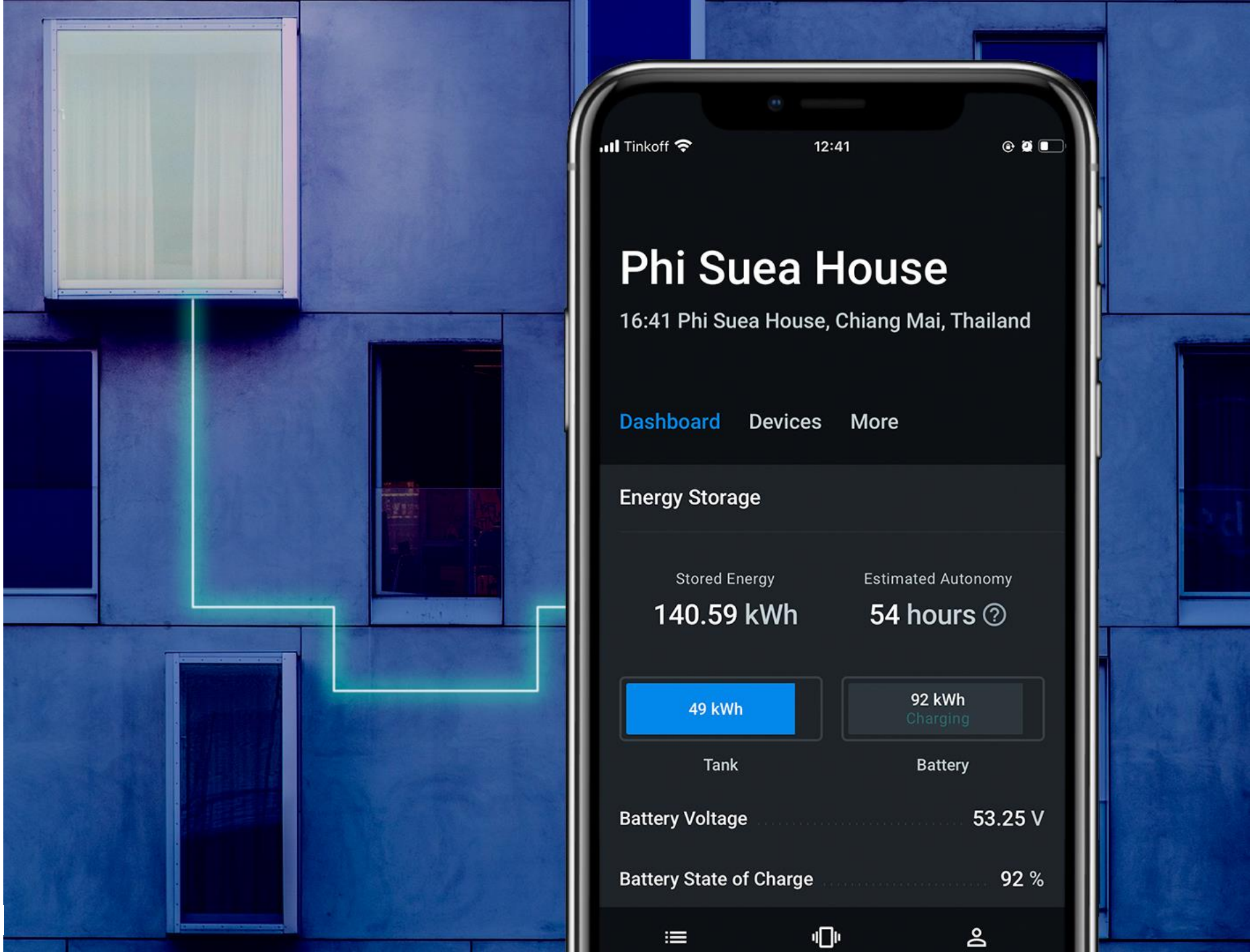
EASY CONFIGURATION AND CONTROL

Mobile & Web Application

Web, mobile, and voice control. Any device, any network, anywhere.

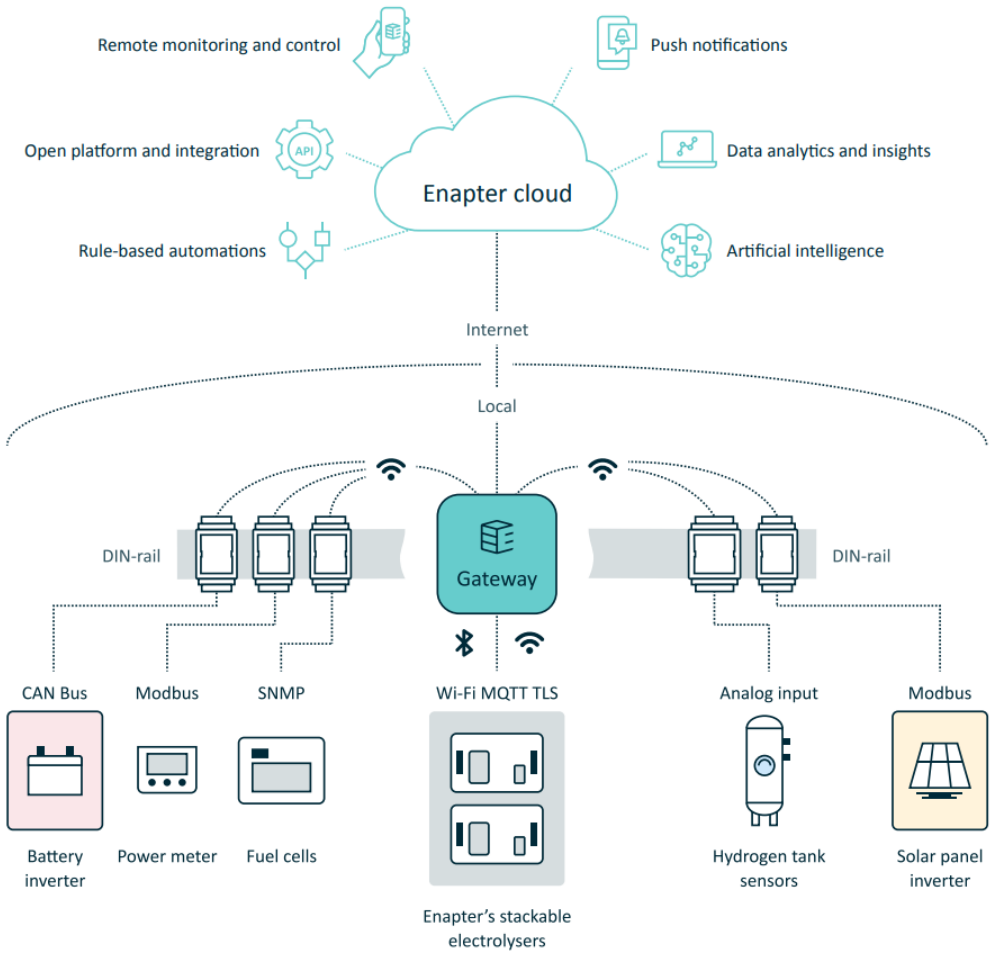
Software enables the AEM Electrolyser

- Enapter provides a toolkit for energy monitoring and control
- Setup time in minutes
- Any energy device can be integrated
- Industry-grade security standards
- All protocols are supported
- Microgrid control
- Over-the-air (OTA) updates
- Rule-based engine
- Machine Learning ready



SYSTEM ARCHITECTURE

Creating your Energy Management System



RULE ENGINE

Rule based management

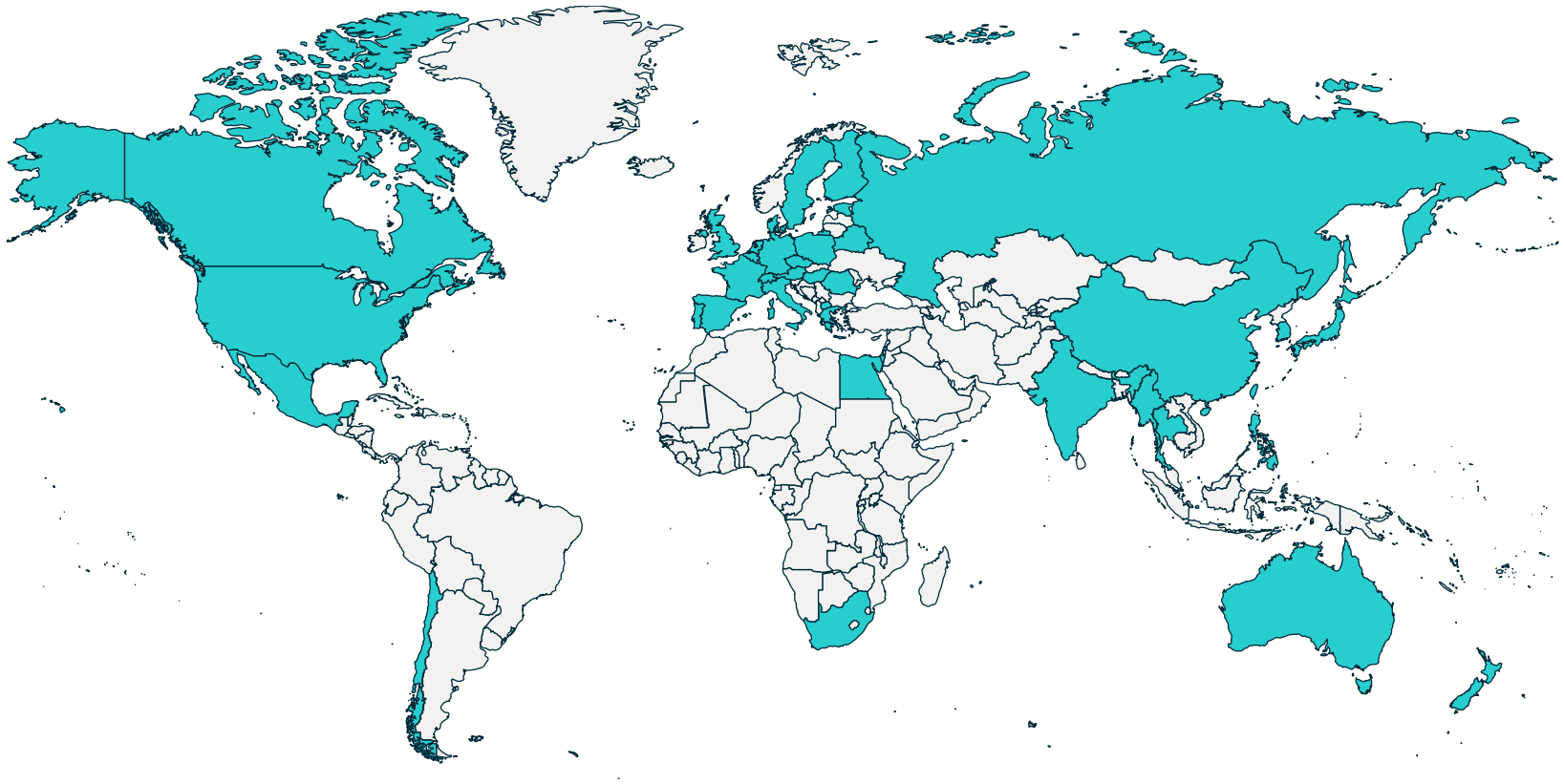
IF solar irradiance is **>600 WATT/SQM** **THEN** **START** Electrolyser

IF battery voltage is **<48V** **THEN** **START** Fuel Cell

Energy systems can be easily controlled with user-defined rules.

AEM ELECTROLYSER ROLLOUT

Enapter‘s global product traction



So far, we have shipped electrolysers to 166 customers in 40 countries.

Currently, we have more than 70 integration partners for our electrolysers, 27 of them are Certified Enapter Partners.

Data as of May 2021

ELECTRICITY STORAGE

The Phi Suea House

The Phi Suea House (Home of the Butterflies) is the world's first solar-hydrogen multi-house:

- Off-grid since 2015 in Thailand, it is a showcase for sustainable living
- Sunshine and rain cover all energy and water needs on the premises, facilitated by Enapter electrolysers.
- In simple terms, the energy of the sun is transformed via solar panels into electricity. Any excess power will be converted and stored as hydrogen. When the sun doesn't shine, the stored hydrogen gas in tanks generates electricity by using fuel cells.
- Selected as a "Hydrogen Valley" on the Mission Innovation Platform. It is one of the world's most advanced H2 projects, and is the only one in Southeast Asia. Read more.

ELECTRICITY STORAGE

Lavo Hydrogen Battery

Lavo develops next generation green energy metal-hydride hydrogen storage.

- It's the world's first integrated hybrid hydrogen battery that combines with rooftop solar to deliver sustainable, reliable and renewable green energy to homes and businesses.
- Developed in partnership with UNSW, Sydney, Australia and Design + Industry, LAVO™ is a hydrogen hybrid battery that stores over 40kWh of electricity – enough to power the average Australian home for 2 days.
- Enapter provides the fitted AEM electrolyser. Together with Lavo, they work at the same speed and ambition to make a real dent in climate change.

ELECTRICITY STORAGE

Microgrid

Electrification of rural community with 100% renewable-based microgrid with hydrogen storage.

- PESTECH electrifies 100 community members in Malaysia using PV coupled with hydrogen energy storage system (ESS)
- AEM electrolyser produces hydrogen from excess PV during the daytime
- Hydrogen is stored and electricity is produced with a fuel cell to supply nighttime demand
- Read more about the economics of hydrogen microgrid here

ELECTRIVITY STORAGE

Peak Shaving with Hydrogen

Delta Green is the first energy-independent office building in France, with energy production exceeding user consumption.

- The aim of Delta Green is to showcase complete energy autonomy.
- The energy mix is made up of PV, geothermal and hydrogen storage; with PowiDian integrating the hydrogen solution. Instead of using batteries, the tertiary building uses 2 Enapter electrolysers to store hydrogen for peak shaving.
- The commercial benefit is that hydrogen is converted into electricity to fulfil demand and avoid demand spikes that would result in a higher electricity tariff

POWER TO HEAT

H2 Heating Solutions

In June 2019, the first hydrogen project for residential heating was officially opened in Rozenburg near Rotterdam in the Netherlands, planned by DNVGL.

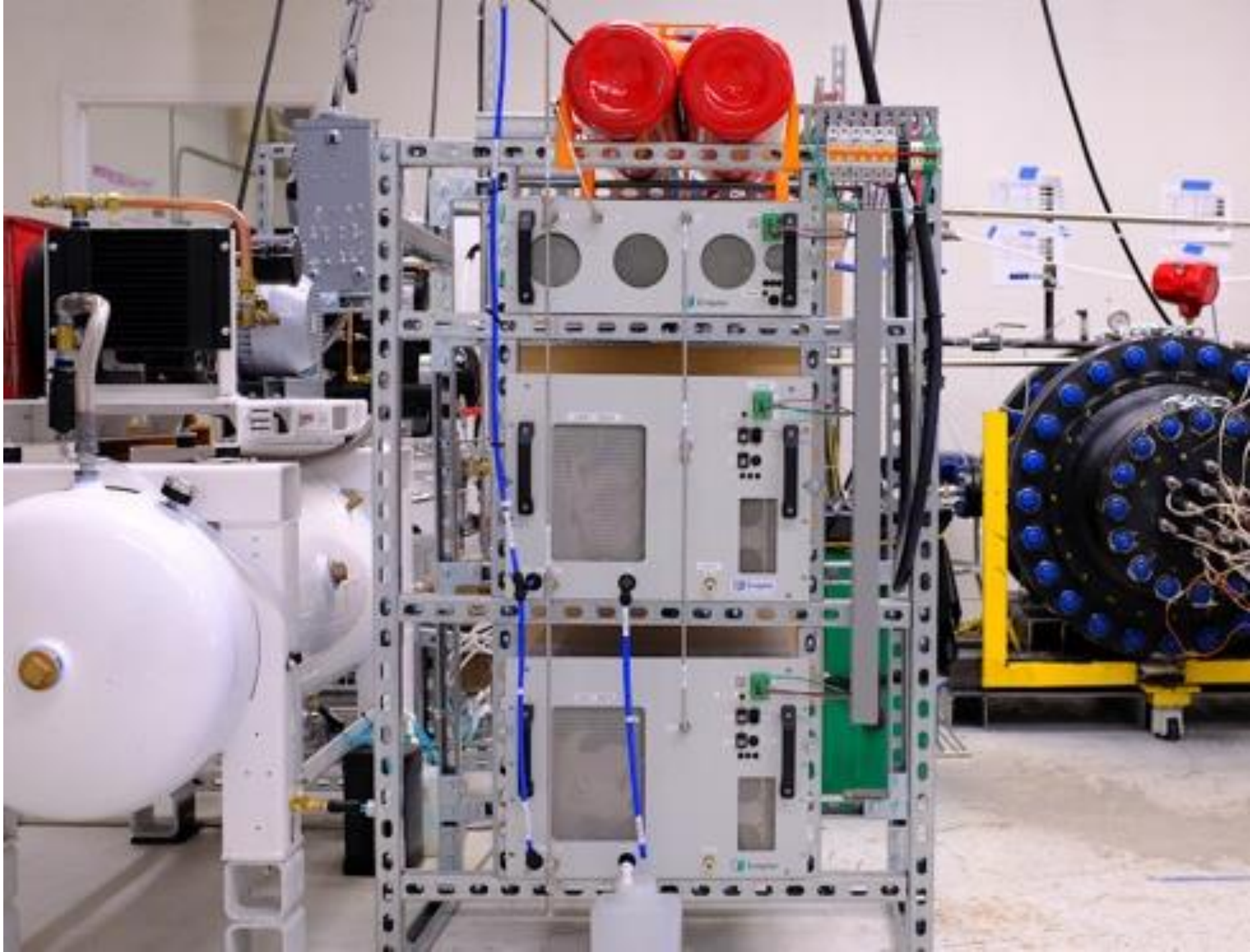
- Enapter deployed 8 AEM electrolysers, showcasing their unique modularity and flexibility.
- The produced hydrogen is safely transported to central boilers heating 25 apartments. 3 different hydrogen boilers are being tested in the setup.
- Since gas production in the Netherlands (Groningen) is winding down, the country has ambitious hydrogen plans to replace natural gas.

POWER-TO-X

Ammonia Production

Starfire Energy is developing modular systems to produce carbon-free Ammonia (NH3) (read more here)

- Ammonia has a high energy density and stores and transports cheaply using well-developed technologies, codes, and standards
- 10 kg/day is first of several iterations, the goal for them is to have a modular NH3 system with a production capacity of 50 tonnes/day
- Modular systems reduce business risk for the customer, which is 100% in line with Enapter's approach



POWER TO GAS

Renewable Methane

In Australia, green hydrogen is upgraded via a methanation process.

- The advantage: methane gas can easy be transported via the existing gas infrastructure.
- Power fuels are the missing link to bring green and environmentally sourced electricity to the heating, transport and industry sectors.
- In Queensland, solar electricity powers an Enapter electrolyser to generate hydrogen. The hydrogen is combined with carbon dioxide extracted directly from the air to create renewable methane.
- Southern Green Gas announced in May 2020 their scaling plans to produce 620kg of green hydrogen to be methanated and injected into existing methane pipelines.

RESEARCH

Biocatalytic Power-to-Methane

- Electricity from solar energy is converted into hydrogen by electrolysis.
- Hydrogen is then converted into natural gas by biocatalysis using carbon dioxide.
- The produced methane can be stored in the existing infrastructure.
- Carbon dioxide is produced during alcoholic fermentation, for example in the production of spirits or beer, but also in the production of bioethanol, which is added to the fuel.

ONSITE REFUELING

H2 Mobility Solutions

Hydrogen vehicles are quickly gaining ground around the globle.

- On-site refueling for fuel cell drones, cars, planes or other vehicles is another use case for decentralized hydrogen procution.
- Enapter is working with Hyperion Motors to supply the Hypercar with the clean fuel it needs for power.
- The HyFlyer project aims to decarbonise medium range passenger aircrafts using hydrogen.

CUSTOMERS AROUND THE WORLD

166 customers in 40 countries to date

Many more here

Enapter datasheets and manual links

Electrolyser EL 2.1	DATASHEET	MANUAL
Electrolyser EL 2.1 LC (Liquid Cooled)	DATASHEET	MANUAL
Electrolyser EL 2.1 DC (Direct Current)	DATASHEET	MANUAL
Dryer DRY 2.1	DATASHEET	MANUAL
AEM Multicore	DATASHEET	BROCHURE
Energy Management System	DATASHEET	BROCHURE

Use Cases	LINK
Enapter Handbook (Full Documentation Available Online)	LINK

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